AMD Geode™ GX 533@1.1W Processor Typical Power Consumption Determination

1.0 Scope

This document describes how the AMD Geode™ GX 533@1.1W processor's* typical power consumption of 1.1W was determined.

2.0 Discussion

Addressing the need for processors in embedded x86 applications to be rated with something more than just clock frequency, AMD created the Performance-Power Rating (PPR) system. A critical component of the PPR system is the typical power consumption of the CPU core. Since the AMD Geode GX processor family features integrated functionality in addition to the CPU core itself, the task of determining typical CPU core power consumption requires some explanation.

The process used to determine the typical CPU core power consumption in the Geode GX 533@1.1W processor is described in the following subsections.

2.1 What is the AMD Geode™ GX 533@1.1W Processor

The Geode GX 533@1.1W processor is an x86-based embedded system-on-chip with the following functional units:

- 400 MHz x86 CPU core
- 266 MHz DDR SDRAM controller
- 66 MHz PCI bus/arbiter
- Graphics controller

These functional units communicate with each other as peripherals on an internal crossbar switch known as the GeodeLink™ Interface Unit (GLIU).

2.2 Defining CPU Core Power

Since Geode GX processors typically compete with x86 processors that consist of an x86 CPU only, power comparisons with these other processors should be done using the Geode GX CPU core power only. Power consumed by the additional integrated features must be eliminated. To do this, the power being supplied to the Geode GX processor's core voltage input must be measured. Then, the power consumed by the integrated features must be subtracted from this measurement, leaving only the power consumed by the x86 CPU core.

2.3 Method for Measuring Device Core Power

The Geode GX processor's device core power consumption is measured using the following method:

1) The power supplied by the system's processor core regulator to the Geode GX processor's core voltage input is configured for measurement by placing a 0.01 ohm resistor in series with this regulator's output, and connecting a precision voltmeter channel across this resistor (V1). An additional voltmeter channel is used to measure the voltage from the load side of this measurement resistor to ground (V2).

2) A specific task is then executed on the Geode GX system while V1 and V2 are measured once per second over the duration of that task. For the purpose of rating the Geode GX 533@1.1W processor's power consumption, the task was defined to be a complete run of WinBench99 Business Graphics while in Microsoft® Windows® XP Pro Service Pack 1. This keeps the GX processor fully occupied for the duration of the benchmark and is therefore a good indication of near-100% CPU utilization.

3) Power for each set of n measurements is calculated using the following equation:

$$P(n) = (V1(n) / 0.01) * V2(n)$$

4) Average device core power for the given task is then calculated by adding all P values and dividing by n. The Geode GX 533@1.1W processor's average core power consumption, while running WinBench99 Business Graphics, is 1.957W.

*The AMD Geode GX 533@1.1W processor operates at 400 MHz. Model numbers reflect performance as described here: http://www.amd.com/connectivitysolutions/geodegxbenchmark.

2.4 Breaking Down Device Core Power

Now the 1.957W figure must be broken down to include only the power consumed by the functional units that are found in a typical x86 processor. Figure 2-1 is a simplified block diagram of the Geode GX processor indicating which functional units are normally found in a discrete x86 microprocessor. Figure 2-2 on page 3 shows the percentage of total GX 533@1.1W processor core power that each of these internal functional units consumes. This data was obtained through simulations and measurements by the Geode GX 533@1.1W processor design team.

Many of these features were added to the GX processor to remove the need for an external north bridge and graphics controller. These extra features include the display logic, the PCI bus controller/arbiter, the memory controller, the GLIU, and the Dot Clock PLL. The power consumed by these units is ignored since they are not found in a typical x86 processor.

Features in Figure 2-1 that are found in a typical discrete x86 processor and the percent of total device core power they consume are listed below:

- x86 Instruction Decode and Execution (21%)
- x86 Floating Point Unit (8%)
- L1 Instruction and Data Caches (24%)
- Other (CPU PLL, etc.) (4%)

The sum of the above percentages is equal to 57%. Therefore, 57% of the total device core power consumed by the Geode GX processor can be fairly compared to the device core power of typical discrete x86 processors.

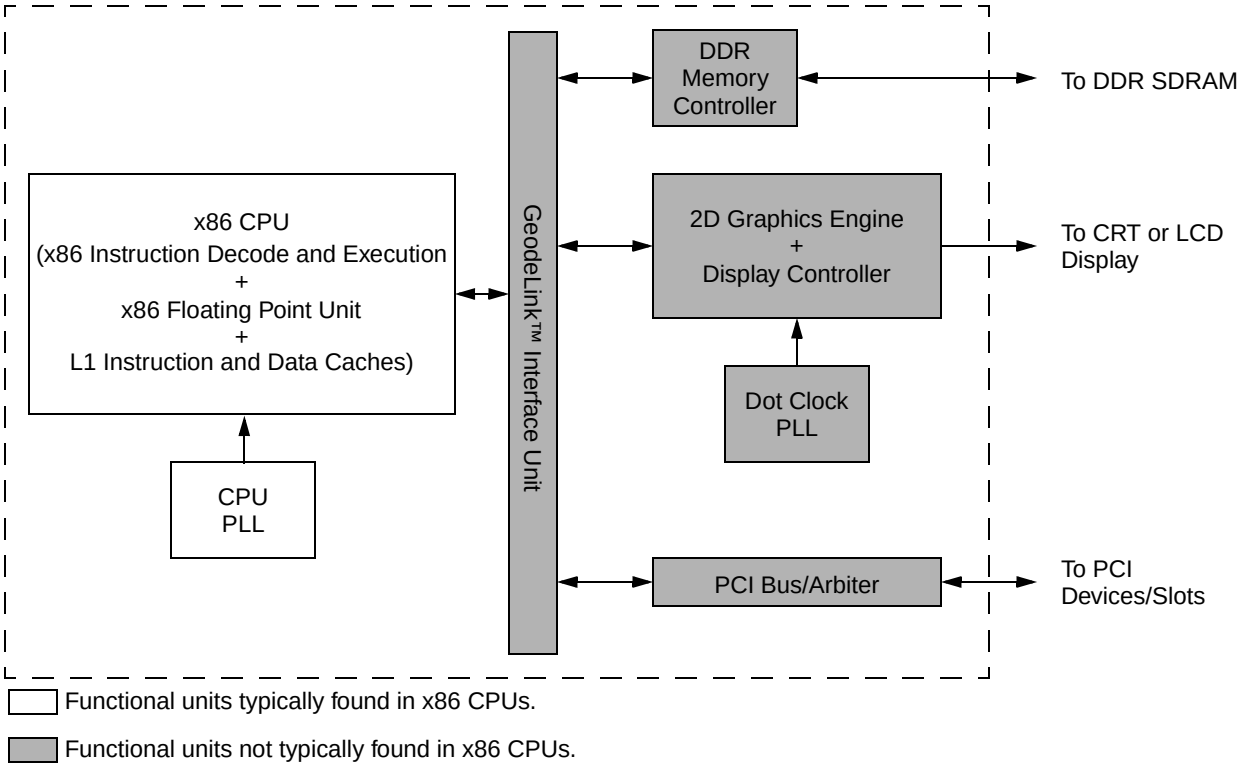
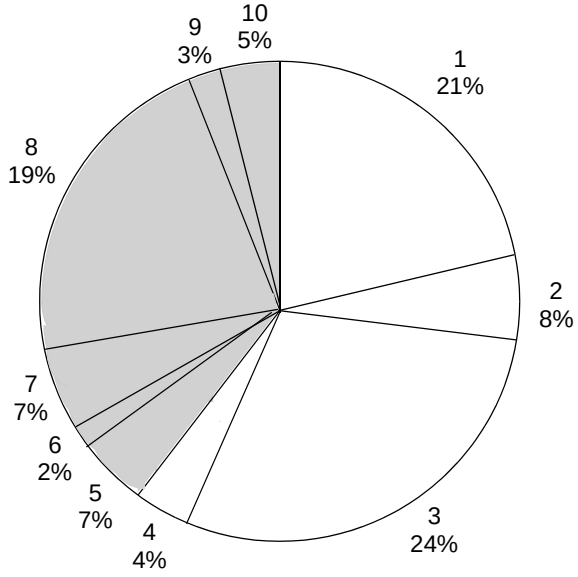


Figure 2-1. AMD Geode™ GX Processor Block Diagram



1 - x86 Instruction Decode and Execution
2 - x86 FPU
3 - L1 Instruction and Data Caches
4 - Other (CPU PLL, etc.)
5 - Other (Dot Clock PLL, etc.)
6 - 2D Graphics Engine
7 - GeodeLink™ Interface Unit
8 - Display Controller
9 - PCI Bus/Arbiter
10 - DDR Memory Controller

Percent total CPU core power used in each block of the Geode™ GX 533@1.1W processor during WMP decode (while Microsoft® WIndows® XP Pro CPU meter indicated 100% CPU utilization.

Figure 2-2. Percent of Total AMD Geode™ GX 533@1.1W Processor Core Power

2.5 Defining Typical CPU Core Power

The results from Sections 2.3 and 2.4 on pages 1 and 2 respectively were used to define typical power for the Geode GX 533@1.1W processor. The measurement of 1.957W average device core power while executing WinBench99 Business Graphics locally in Windows XP Service Pack 1 was used for this calculation in order to make it a conservative measure. Since this benchmark runs at nearly 100% CPU utilization, power defined using this method is actually closer to maximum power than typical power.

Using 1.957W from Section 2.3 and 57% of Geode GX device core power from Section 2.4 on page 2, typical power for the Geode GX 533@1.1W processor can be calculated:

1.957W * 57% = 1.115W

Rounding this result yields 1.1W.

3.0 Summary

This document clearly describes how the Geode GX 533@1.1W processor's typical power rating of 1.1W was obtained. It shows that this measure is conservative and that many applications could yield even lower typical CPU core power consumption with this device.

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